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Description

The present invention relates to the removal of bran from cereal grains and milling of flour and/or semolina production. In particular, the present invention relates to a method and apparatus which subjects the grain kernels and particularly wheat kernels to process steps prior to subjecting them to the traditional tempering operation in preparation for milling.

The general objective of the milling process is to extract from the wheat kernel the maximum amount of endosperm in the purest form. The endosperm is either ground into flour or semolina. This requires the efficient separation of the components of the wheat kernels, namely the bran, endosperm, and germ. Bran and germ have a detrimental effect on the end milled products, flour or semolina.

In the conventional milling process, after the initial cleaning steps, the wheat kernels are conditioned with water and/or steam and allowed to rest in temper bins for 4 to 20 hours (tempering) to toughen the bran coats of the wheat kernels and soften or mellow the endosperm. Tempering of the wheat kernels fuses the bran coats together and is an essential conditioning step of the kernels carried out prior to the conventional milling process to alter the physical state of the kernels in a desired manner. Tempering is undoubtedly the most important factor in determining the amount of endosperm produced from given wheat kernels and, therefore, great care is taken to appropriately condition the kernels prior to milling.

The tempering of the wheat kernels to toughen and fuse the bran coats, unfortunately, also causes some fusion of the endosperm to the inner layers of bran whereby separation of these components is more difficult. The conditioned kernels are then subjected to successive stages, each of which grind, separate and purify the product. The first grinding operation (first break) opens the tempered kernels to expose the endosperm and scrape a portion of the endosperm from the bran. The coarsely ground mixture of bran, germ and endosperm particles is then sifted to classify the particles for further grinding, purification or sifting. The finer classified particles, which are a mixture of endosperm, bran and germ are then sent to the appropriate purification steps. The coarse remainder, consisting of bran and adhering endosperm, is sent to the next grinding step (second break) to remove more of the endosperm from the bran. The process of grinding, sifting and purification is repeated up to five or six times (5 or 6 breaks) in a conventional mill. However, each grinding process produces fine bran particles (bran powder) and germ particles which have a tendency to be separated with the endosperm and are difficult, if not impossible, to remove from the endosperm. Each grinding operation produces more and more bran powder, compounding the problem.

Effective removal of the bran from the endosperm (flour and semolina) remains a problem affecting the yield possible from given wheat kernels as well as the fixed capital cost of a mill and the variable costs for milling high grade patent flour, and/or semolina.

FR-A-778710 describes a process and machine for husking and conditioning wheat and other cereals or grains which comprises initially moistening the wheat, then subjecting the wheat to the sequential steps of agitation, passing the wheat between rough surfaces, and finally through a series of brushes. The husks are removed by a conventional ventilating process.

According to the present invention there is provided a process for treating wheat kernels having an endosperm and germ encased in a layered bran coat, said process being intended to substantially remove the exposed bran coat and being characterised by comprising, prior to the tempering and conditioning step of a conventional milling process, the following steps, while maintaining the endosperm (6) substantially integral: moistening the clean dry wheat kernels (2) with water to an amount of about 1 to 3%, by weight of the kernels, sufficient to condition the outer layers of the bran coat without fusing the layers together, feeding said kernels, within a period of one to about five minutes after application of the water, in a continuous stream through friction operations to substantially remove and separate the four outer bran layers and feeding said kernels in a continuous stream through abrasion operations to remove and separate the inner bran layers. In contrast to the conventional practice, the wheat kernels, processed according to the present process, are not subjected to tempering initially, as this would fuse the various bran layers. The kernels are processed to effectively strip these bran layers from the endosperm prior to tempering of the wheat kernels. The initial four layers of the bran coat are removed preferably by initially conditioning the outer bran layers with a small amount of water, about 1 to 3% by weight. This water does not fuse the entire bran coat, but merely serves to loosen the outer layers. Timing between applying the water and stripping the layers is important and the wheat kernels are processed essentially immediately, within 5 minutes, in contrast to the required several to many hours for tempering. The conditioned kernels are fed to a series of friction machines to remove the outer bran layers. The friction operations for stripping of the bran layers, in some cases, can be enhanced by fogging of the wheat kernels prior to processing in the friction operation. Fogging of the kernels is not to be confused with a tempering operation. Tempering fuses the various bran layers such that sequential removal of the individual layers is not possible, fogging only

adds enough moisture to enhance separation of the layers. Abrasive operations follow the friction operations and are required to remove the inner bran layers, namely the seed coat, nucellar (hyaline) layer and aleurone layers. Both the nucellar layer and aleurone layer tend to polish in friction operations. It should be recognised that the above process for sequentially removing the bran layers will not be 100 percent effective, however the pre-processed kernels will have most of the bran coat removed and as such, the difficulties with respect to bran contamination and separation of the various desired components of the wheat kernel is greatly reduced. This allows the downstream processes of conventional milling to be simplified and/or more effective. All the bran coat is not removed by the present process as the bran within the crease, for the most part, remains intact. A further advantage is that the friction and abrasion operations can be adjusted to strip and separate the various layers of the bran coat. Each layer or group of layers has unique properties and can be processed to produce a product of increased value. In addition preprocessing the kernels removes the bran layers including the seed coat prior to milling thereby improving the colour and appearance of the milled products: flour or semolina.

Preferred embodiments of the invention as shown in the drawings wherein;

- Figure 1 is a flow chart showing the various steps of the present invention;
- Figure 2 is a perspective view of the wheat kernel with a portion of the bran layers cut away;
- Figure 3 is a cross-section taken through a wheat kernel;
- Figure 4 is a sectional view of a friction machine;
- Figure 5 is a cross-section of the milling chamber of the friction machine of Figure 4;
- Figure 6 is a sectional view of an abrasion machine; and
- Figure 7 is a cross-section of the milling chamber of the abrasion machine of Fig. 6.
- Figure 8 is a perspective view of the abrasive roll and co-operating components of the abrasive machine of Fig. 6.

Figure 9 is a flow sheet showing a preferred embodiment of the apparatus of the present invention.

- The wheat kernel 2, generally shown in Figs. 2 and 3, has a bran coat 4 made up of several different layers identified at 10 through 20. Interior to the bran coat is the endosperm 6 with the wheat germ generally identified as 8. In general, the bran layers collectively make up about 15% by weight of the wheat kernel, whereas the germ represents about 2.5% and the endosperm represents about 83% by weight of the wheat kernel.

- The layers of bran from the outer to inner layer are:

- epidermis 20
- hypodermis 18
- cross cells 16
- tube cells 14
- seed coat 12
- nucellar tissue (hyaline layer) 11
- aleurone cells 10

- In the cross-section of Fig. 3, a portion 5 of the seed coat 12 is located within the crease 7 of the wheat kernel 2. It should be noted that the bran layers do extend within the crease 7 and this bran is left substantially intact by the present invention to be removed subsequently by conventional milling techniques.

- The aleurone layer 10 is quite thick and acts as a tolerance zone for the last abrasion operation. It is desirable to leave some of the aleurone layer 10 to ensure the maximum amount of endosperm is processed to maximize the yield. In general, if the bran layers removed during the operation of the present invention equal about 10% by weight of the initial feed, most of the aleurone layer will have been removed from the wheat kernels.

- The wheat kernel 2 generally shown in Fig. 2 is illustrated with the various layers of the bran partially peeled on the left side of the kernel and, the present process, seeks to peel away or remove these layers. It has been found that the use of a series of friction operations followed by a series of abrasion operations applied to the kernels prior to the tempering of the kernels will allow various layers of the bran coat 4 to be sequentially removed and separated from the wheat kernels. It is not essential that each layer be removed independently of an underlying layer and, in fact, the operations are such that two or more layers are removed or partially removed at the same time. In effectively stripping or peeling of these layers from the wheat kernels, some of the underlying layer may also separate and therefore, although the operation as described with respect to the flow chart of Fig. 1 discusses removal of particular layers, some portions of other layers may also be removed.

The process for removing the bran layers is generally shown in Fig. 1. This process is upstream of the traditional milling process and, in particular, in advance of the tempering of the wheat kernels. Traditional steps for removing debris, dirt, etc. have already been completed. The process begins by placing clean, dry

wheat kernels indicated as 200 into a dampening mixer 202 and adding water in an amount equalling about 1-3% by weight of the kernels. The amount of water added depends on the initial moisture of the wheat and the hardness of the wheat. In general hard wheat will require more water to be added than soft wheat varieties. The mixer 202 serves to ensure uniform distribution of moisture to the kernels and the outer layers of the bran coat effectively absorb most of the water. The water penetrates to about the nucellar tissue layer 11 which repels the water to a certain extent, due to its higher fat content. The repelled water serves to part the layers to assist in removal by friction. The kernels are moved through the dampening mixer 202 in about one minute and delivered, as indicated by line 206, to a holding bin 302 in advance of the first friction operation. The holding bin 302 permits that adequate supply of wheat is available to be processed in the subsequent process steps. In addition hold time in the bin 302 can be adjusted to permit the moisture to penetrate the bran layers. The penetration time varies from variety to variety depending on, among other factors, the hardness of the wheat. Insufficient penetration results in difficulty in removing the bran layers and too much penetration results in too many layers being removed at one time and an increase in power consumption. The kernels are moved from the holding bin 302 preferably within one to five minutes to friction machine 208 which brings the kernels into friction contact with one another as well as friction contact with the machine or various moving surfaces of the machine. The movement of the kernels from the dampening mixer 202 to the holding bin 302 is indicated by arrow 206 and from the holding bin to the friction machine by arrow 306. The friction machine 208 effectively strips the outer bran layers, namely the epidermis 20, the hypodermis 18, and some of the cross cells 16. These layers are removed from or separated from the remaining kernels and are discharged from the friction machine along the line indicated as 210. A second holding bin 304 is provided for the wheat kernels exiting the first friction machine to ensure a continuous flow to the second friction operation and to provide the kernels with a short term relaxation. The partially processed kernels are then transported, as indicated by line 214, to a second friction machine 215 which removes the remaining cross cells 16, the tube cells 14 and in some wheat varieties part of the seed coat 12. It has been determined that fogging of the kernels using about 1/4% to 1/2% by weight of atomized water can be introduced in the second friction operation 215 to loosen and assist in separating the layers being removed. The removed layers are separated from the kernels as indicated by line 220, with the processed kernels being passed to a third holding bin 308 as indicated by line 216. Holding time in bin 308 is sufficient to permit relaxation of the wheat kernels prior to commencing abrasion.

The kernels are then moved from holding bin 308, as indicated by line 222, to the first abrasion operation 224. Abrasion machine 224 removes most of the seed coat 12 and some of the nucellar tissue 11 and the aleurone cells 10 which are discharged as indicated by line 226. The stripped kernels are passed, as indicated by line 228, to holding bin 310. The kernels are then fed, as indicated by line 320, to a second abrasion machine 230 which removes most of the remaining seed coat, nucellar tissue and aleurone layer. The separated layers are removed as indicated by line 232.

The bran layers removed during each operation are collected and separately processed or stored. For example the particles removed during the first friction operation and the second friction operation are collected and delivered through an expansion chamber to separate any breakage and germ from the removed bran layers. The removed bran layers are delivered to filter receivers from which the product is discharged to a collecting system for storage. It has been determined that the first four layers of the bran are high in dietary fibre and relatively low in phytate phosphorous. Phytate phosphorous has been shown in some studies to inhibit mineral absorption in the human body and accordingly low phytate phosphorous levels in dietary fibre products which can be used as fibre additives in other foods may be desirable. For this reason the first and second friction operations can be adjusted to minimize the removal of the seed coat, nucellar tissue or aleurone layers which have higher phytate phosphorous levels.

After the second abrasion operation the bran coat has been substantially removed from the wheat kernels other than in the crease area and the preprocessed kernels are moved, as indicated by line 234, to the brushing apparatus indicated as 236. The brushing operation removes bran powder from the crease of the wheat kernels and serves to loosen the germ. Bran powder and loosened germ are removed as indicated by line 238. The resulting kernel, which now is essentially the endosperm, crease bran and germ is fed from the brush 236 to a static cooler 240 to cool the wheat to about 70-90 ° F. Heat generated during the friction and abrasion operations unless otherwise dissipated, may result in the temperature of the wheat being in excess of 90 ° F. upon exit from the last abrasion operation. Temperatures in excess of 90 ° F. are undesirable in order to mill the preprocessed kernels. As an alternative to the static cooler 240 other methods of maintaining the temperature of the wheat at acceptable levels can be utilized so long as the wheat delivered to the tempering bins is between 70-90 ° F. The kernels which leave the static cooler 240 as indicated by line 244 may now be conditioned by adding moisture in a second dampening mixer 312 to

bring the moisture level in the wheat kernels up in order that the endosperm is properly mellowed for milling and to toughen and fuse the remaining bran in the crease. The time for conditioning the wheat and fusing the bran in the crease can take substantially less time and less grinding, separating and purifying steps will be required to achieve the same or a higher degree of extraction and purity in milling than
 5 achieved using current techniques.

According to the process of the invention the endosperm remains integral during removal of the bran coat. The preprocessing steps are carried out before tempering of the kernels which would have fused the bran layers and mellowed the endosperm. The non-tempered endosperm is somewhat hard and acts as an interior support during the friction and abrasion operations.

10 Although two friction machines are shown and two abrasion machines are shown for separating the various bran layers, some of these operations can be combined if a lesser degree of separation of individual bran layers is desired or more machines may be provided if greater control is warranted.

The friction machines suitable for operation of the present invention preferably use the friction of individual grains rubbing against each other to peel the bran layers away.

15 One friction-type machine for removing bran layers is shown in Figures 4 and 5 has a hopper 102 for receiving the wheat kernels to be processed. The received wheat kernels are advanced by the screw feed 104 along the axis of the machine to a bran removing section 106. A milling roller 108 is provided and consists of a vaned hollow shaft carried on a hollow drive shaft 110. The rotation of the milling roller 108 causes the wheat kernels to be in friction contact with each other or friction contact with the milling roller
 20 108 or outer screen 112. In friction machine 100, the wheat kernels remain in contact with each other throughout the bran removing section 106. The milling roller 108 causes the kernels to move rotationally about its axis as they are advanced through the length of the machine. The wheat kernels are discharged from the machine at the discharge chute 114 having a control member 116. The control member 116 is adjusted by the lever and weight arrangement 118. By increasing or decreasing the force exerted on said
 25 control member 116 by means of a lever and weight arrangement 118, a greater or lesser back pressure can be created and this allows control of the amount of bran removed as it is processed through the machine. The milling roller 108 cooperates with the outwardly disposed screen 112 which is appropriately sized to allow removed bran to pass therethrough. The width and angle of the slots in the screen also control the amount of bran removal. To encourage bran to pass through the screen 112, air is introduced
 30 through the drive shaft 110 at 122. The drive shaft 110 has vent holes 124 along its length which permit the air to pass into the space between the drive shaft 110 and the milling roller 108. Slots 125 are provided in the vanes 126 of the milling roller 108 and the air passes through these slots 125 and makes its way through the wheat kernels carrying removed bran to and through the screen 112. The bran is collected and suitably discharged from the machine.

35 The milling roller 108 and screen 112 are schematically shown in vertical cross-section in Figure 5. The arrow 127 indicates the direction of rotation of the milling roller 108.

The abrasion machine 150 of Figures 6, 7, and 8 uses a series of an abrasive stones 152 which cooperate with an outer concentrically disposed slotted steel screen 154. The machine includes an intake hopper 156 for receiving the partially processed wheat kernels, and the processed kernels are discharged at
 40 chute 158. The abrasive stones cut the bran layers from the surface of the wheat kernels as the they come into contact with them. The series of abrasive stones 152 is followed by a short friction or polishing section 170 whose primary function is to remove loose bran generated by the abrasive stones 152. This friction section 170 consists of a smooth hollow steel roll 172 to which resistance bars 174 are attached and in which there are a series of slots 176. The slots 176 permit high pressure air fed to the smooth hollow steel
 45 roll 172 to pass into the cavity between the steel roll 172, stones 152 and screen 154 and help facilitate the transfer of removed bran through the screen as well as acting to control the temperature of the wheat kernels and the stones 152. The abrasion machine 150 is also provided with a series of adjustable resistance pieces 178 along the bottom of the milling chamber 180 which can affect the pressure on the wheat kernels within the milling chamber 180. Control member 160 varies the opening pressure of the
 50 discharge chute to thereby vary the back pressure. Adjustment is made by means of the lever arm and weight arrangement 162. As noted above air under pressure is introduced into the discharge end of the abrasion machine and is axially discharged through the steel roll 172 to cool the wheat kernels and urge removed bran layers to pass through the slotted steel screen 154. The air also serves to clean the kernels of small bran particles. The removed bran layers pass through the slotted steel screen 154 are collected
 55 and discharged separately. If moisture is added in the abrasion machine it has been found that there is a tendency for the abrasive stones to become fouled.

Both friction and abrasion machines preferably can be adjusted to provide satisfactory control of the bran layers removed, regardless of the size of the kernels and so that there is no free movement of kernels

to avoid breakage. Total control of the bran layers removed in each step is not required, however effective control of each operation can increase the yield by assuring the endosperm remains essentially intact.

In both the friction and abrasion machines there are several factors which can be used to control the bran removal at any stage of the process:

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(a) Pressure within the Bran Removal Chamber

(i) The pressure within the bran removal chamber of both the friction and abrasion machines is controlled by adjusting the magnitude or position of the weights on the lever arms located at the discharge of the machine. The greater the weight placed on the lever or the further out on the lever the weight is placed the greater the pressure in the bran removal chamber and the more bran layers removed;

10

(ii) Variable Resistance Pieces

In the abrasion machine the angle of the resistance pieces at the bottom of the milling chamber to the wheat flow can be adjusted to increase or decrease the pressure. This is the primary adjustment in the abrasion type machine. The greater the angle the more bran removed.

15

(b) Screen Configuration

In both the abrasion and friction machines, the width of the slot in the screen and the angle of the slot with respect to the longitudinal axis of the machine affect the degree of bran removal. In general, the wider the slot and the greater the angle of the slot, the greater the bran removal. It is important not to increase slot width so that broken bits or whole grains can pass through the slot.

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(c) Grit of Abrasive Stones

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Generally the smaller the mesh or grit number of abrasive stone, the more bran removal is obtained. In addition, the hardness of the stones impacts on bran removal. Soft stones will result in greater bran removal, however soft stones wear more rapidly than hard grit stones. Also, the smaller grit number stones (coarse) result in a rougher finish on the kernels.

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(d) Speed of Rotation

The faster the speed of rotation of the milling roll the more bran removed.

Both friction and abrasion machines utilize the endosperm as an internal support for stripping the bran from the kernels. This approach is in direct contradiction to the use of grinding apparatus in the conventional process which not only breaks the fused bran coat, but also breaks the endosperm. This results in a host of fragments of bran, germ and endosperm which essentially must be commonly processed in an effort to efficiently separate the endosperm from the bran. This is a very difficult problem as it requires further grinding or breaking of the fragments, which in turn creates more bran powder which is extremely difficult to remove from the powdered endosperm.

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These problems are substantially reduced with the present process since approximately 75% of the bran has been removed.

In the milling of certain high fibre flour, some of the removed bran layers may be added back after the endosperm has been milled into flour. This will allow a greater degree of accuracy with respect to the actual type of fibres in the flour and the amount thereof.

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The present process, if desired, could be completed as a separate step and the processed kernels stored for later milling. Also, the processed kernels can be reintroduced to any of the friction and abrasion operations if for some reason they are not satisfactorily processed. These advantages of partially processing the kernels and/or the ability to reprocess material add flexibility in a system which previously was essentially inflexible.

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The process as generally indicated in Fig. 1 is designed to allow separation of the bran layers in a sequential manner where the separated bran layers, if desired, can be used for specialized products. This separation cannot be accomplished with the conventional process in that the bran layers have been fused. By sequentially removing and separating the bran layers, more specialized and profitable products can be produced. Therefore, not only is the separating of the bran layers important with respect to milling of the endosperm, it is also important as valuable by-products are created.

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Advantages of the present process and apparatus include:

- a) Purer/cleaner flour and semolina as bran and/or germ contamination has been reduced;

- b) Reduced capital expense as the number of grinding, separating and purifying steps are reduced;
- c) Opportunity to increase throughput of existing mill using preprocessed kernels;
- d) Higher endosperm extraction rates;
- e) Reduced process steps for given yield;
- 5 f) Reduced technical skills for carrying out the process; and
- g) Substantially increased flexibility in processing the kernels to improve extraction rate by adjusting preprocessing equipment and/or repeating certain preprocess steps.

In the flow diagram in Fig. 9, clean dry wheat from the cleaning house is fed to storage bins 401. The wheat is subsequently fed through wheat measures 402. to set the load through the system. The wheat is
 10 fed from measures 402 to a technovator mixer 404 at which time 1-3% atomized water is added. The amount of atomized water added is controlled by air and water controls 403.

The wheat is then conveyed to holding bin 405 with level controls to control penetration time and to shut down the system if there is any interference in the flow to or through the friction machines.

The wheat is fed to two friction machines 406 each operated by a 40 hp (29,81 KW) motor running at
 15 750 RPM. The removed bran, germ and broken bits are collected in hopper 406A and carried on a stream of air to expansion chamber 409 where the broken bits and germ are separated from the removed bran layers. The air and removed bran stream is passed to filter receiver 410 where the removed bran (Product A) is separated from the air and collected separately or collected with Products B and C and conveyed to a sifter for grading, grinding and storage.

The wheat discharged from friction machines 406 is fed to holding bin 407 and then conveyed to friction machine 408 operated by a 50 hp (37,16 KW) motor at 750 RPM. Atomized water (about 1/4-1/2%) is added to the wheat upon being fed to the friction machine 408 by control 408B. The removed bran, germ and broken bits are collected in hopper 408A and collected with the removed bran, germ and broken bits from friction machines 406 and handled in the same way.

The wheat exiting friction machine 408 is conveyed to holding bin 411. There is a 10-15 minute holding capacity in bin 411 for relaxation and load control prior to the abrasion operation. The wheat is then fed to abrasion machine 412, operated by a 60 hp (45,72 KW) motor at 942 RPM, which has a split hopper 412A to collect the removed bran layers, germ and broken bits. These removed bran layers, germ and broken bits are conveyed through expansion chamber 413 where the broken bits and germ are separated
 30 from the air stream. The air and bran are passed to filter receiver 414 for separation of the removed bran from the air stream. This removed bran can be collected as Product B or collected together with a Product A and Product C and fed to a sifter for grinding, grading and storage.

The wheat exiting abrasion machine 412 is delivered to holding bin 415 with a 5 minute holding capacity for relaxation and load control. The wheat is then fed to abrasion machine 416 operated by a 60 hp
 35 (45,72 KW) motor at 942 RPM. The removed bran, germ and broken bits are collected in split hopper 416A passed through expansion chamber 417 to remove the broken bits and germ and then to filter unit 418 for removal and handling of the bran as Product C in a similar fashion as the bran products removed from filter units 410 and 414.

The wheat exiting abrasion machine 416 is fed to wheat brush 419 to remove crease bran powder and
 40 loosen the germ. Aspiration chamber 420 in the wheat brush 419 removes dust and separates any broken bits and germ.

The wheat is then delivered to a static cooler 421 (cold water radiators) to cool the wheat. Aspiration chamber 422 in static cooler 421 removes any loose dirt and assists in the cooling of the wheat.

The broken bits, germ and bran powder from aspiration chambers 420 and 422 are collected and
 45 delivered to the stream of removed products exiting abrasion machine 416 prior to delivery to expansion chamber 417.

The main stream of wheat from the static cooler 421 is fed to a technovator mixer 424 where additional atomized water (1-4% by weight) is added to mellow the endosperm and fuse the remaining bran in the crease. The addition of moisture is controlled by control 423.

The wheat exiting the technovator 424 is delivered to a mixing distribution conveyor 426 to deliver the dampened wheat to temper bins 427. A cooling hood 425 is placed over the mixing distribution conveyor for passing cooler air over the wheat to assist in cooling the wheat down to about 70° to 90° F (21,1° C to 32,2° C).

From the temper bins 427 the wheat is drawn to holding bin 431 and then through magnet 432, wheat
 55 measure 433 and wheat scale 434. The wheat then is fed to a pre-break machine 435 to pre-break the wheat and to loosen the germ. The broken wheat is then delivered to pre-break sifter 436 to remove the germ and separate the broken wheat into stock sizes for delivery to either the break rolls, germ sizing system, purifier or a finished product collection system.

The broken bits and germ removed from expansion chambers 409, 413 and 417 and aspiration chamber 420 and 422 are collected together and passed through aspirator 428 to remove any fine dust from the broken bits and germ. The product exiting aspirator 428 is then joined to the main stream of wheat prior to delivery to technovator 424. Alternatively the broken bits and germ could be tempered separately and introduced to the germ sizing system.

Prior to delivery to brush 419, the wheat can be optionally delivered to additional friction or abrasion machines 430 for additional processing if desired.

Suction fan 429 provides the air requirements of the system for aspiration, cooling and conveying of the by-products from the friction and abrasion machines. The fan also provides suction to aspirate (remove heat) from the mechanical conveying equipment, i.e. elevator legs, hoppers and conveyors.

EXAMPLES

A series of runs were made on different types of wheat from soft wheat to hard wheat in order to assess the operation of the present invention on a wide variety of product types. The apparatus was set up as shown in Fig. 9. The bran product collected in the first and second friction operation has been designated Product A and has been found to contain a high dietary fibre content. Product A consists primarily of the 3-4 outer bran layers and has little or no phytate phosphorous present. The bran layers removed during the first abrasion operation are designated Product B and were separately collected. Product B consists primarily of the middle layers of the bran coat, although some aleurone layers were detected. Product B is high in protein and lower in dietary fibre.

The bran layers removed during the second abrasion operation were designated Product C were also separately collected and consist primarily of the aleurone layers with some seed coat and hyaline layer present.

Products B & C due to their relatively high vitamin content may be a source of vitamins or minerals or utilized in the food and pharmaceutical products.

For analysis the samples of each of product A, B & C were sifted into fine and course particles.

In Examples 1 and 2 the Spanish wheat had "sprouted" and been rejected for milling. Kernels which have sprouted have a high alpha-amylase activity which adversely affects baking characteristics. A test to determine alpha-amylase activity measures the Falling Number. Falling Numbers of 200 or above are considered acceptable for milling. The Spanish wheat initially had a Falling Number of 163 in Example 1 and 118 in Example 2, however after processing by the present invention the Falling Number had increased to 247 and 214 respectively. The wheat after processing was added to a grist of wheat being milled by conventional techniques at a rate of 15%. The baking characteristics of the resulting flour were acceptable.

EXAMPLE NO. 1

GRAIN DESCRIPTION: Spanish Hard Wheat

FEED RATE: 4150 Kg/hr.

MOISTURE ADDED IN DAMPENING MIXER 2.0%

FIRST FRICTION: 750 RPM

SECOND FRICTION : 750 RPM; MOISTURE ADDED 1/4%

PRODUCT A:

AMOUNT RECOVERED: 131 kg/hr.

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ANALYSIS		
	Fine	Course
Oil	1.35%	1.25%
Protein	7.90%	5.60%
Ash	3.30%	2.10%
Moisture	21.4%	20.8%
Calcium (CA)	0.28%	0.25%
Phosphorus (P)	0.27%	0.20%
Potassium (K)	0.90%	0.87%
Dietary Fibre	79.1%	87.5%
Phytate mg/100 gm	102	246

15 FIRST ABRASION: 942 RPM;

PRODUCT B:

AMOUNT RECOVERED: 122 kg/hr.

ANALYSIS		
	Fine	Course
Oil	8.20%	7.30%
Protein	22.5%	19.75%
Ash	8.10%	7.10%
Moisture	10.6%	10.5%
Calcium (CA)	0.13%	0.22%
Phosphorus (P)	1.06%	0.98%
Potassium (K)	2.02%	1.73%
Dietary Fibre	24.4%	41.1%
Phytate (P) mg/100 gm	1577	1308

35 SECOND ABRASION: 942 RPM;

PRODUCT C:

AMOUNT RECOVERED: 142 kg/hr.

ANALYSIS		
	Fine	Course
Oil	6.45%	6.45%
Protein	22.88%	22.10%
Ash	5.15%	5.30%
Moisture	10.3%	10.3%
Calcium (CA)	0.16%	0.13%
Phosphorus (P)	1.04%	0.89%
Potassium (K)	1.41%	1.43%
Dietary Fibre	17.5%	18.4%
Phytate (P) mg/100 gm	981	982

55 BREAKAGE & GERM

AMOUNT RECOVERED: 62 kg/hr.

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% BREAKAGE: 1.5%
FLOW RATE TO TEMPER BINS: 3745 kg/hr.

EXAMPLE NO. 2

5 GRAIN DESCRIPTION: Spanish Hard Wheat (FN = 118)
FEED RATE: 3750 Kg/hr.
MOISTURE ADDED IN DAMPENING MIXER: 2%
FIRST FRICTION: 750 RPM
10 SECOND FRICTION : 750 RPM; MOISTURE ADDED 1/4%

PRODUCT A:

AMOUNT RECOVERED: 112 Kg/Hr.
15 FIRST ABRASION 942 RPM;

PRODUCT B:

AMOUNT RECOVERED: 94 Kg/Hr
20 SECOND ABRASION:

AMOUNT RECEIVED 121 Kg/Hr.

25 BREAKAGE AND GERM

AMOUNT RECOVERED 39 Kg/Hr.
% BREAKAGE 1.1%

30 FLOW RATE TO TEMPER BINS

3413 Kg/Hr.
(F.N. = 214)

35 EXAMPLE NO. 3

GRAIN DESCRIPTION: Danish Hard Wheat (FN = 260)
FEED RATE: 3800 kg/hr.
MOISTURE ADDED IN DAMPENING MIXER 1.5%
40 FIRST FRICTION: 750 RPM
SECOND FRICTION : 750 RPM; MOISTURE ADDED 1/4%

PRODUCT A:

45 AMOUNT RECOVERED 97 kg/hr.

50	ANALYSIS			
		MOISTURE	DIETARY FIBRE (NDF)	
			As Received	Dry Basis
	COARSE PARTICLES	12.81%	69.2%	79.4%
	FINE PARTICLES	12.89%	62.1%	71.3%

55 FIRST ABRASION: 840 RPM;

PRODUCT B:

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AMOUNT RECOVERED: 93 kg/hr.
SECOND ABRASION: 840 RPM;

PRODUCT C:

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AMOUNT RECOVERED: 112 kg/hr.

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ANALYSIS:		
MOISTURE %		10.45
ASH %		4.55
PROTEIN %		16.25
DIETARY FIBRE NDF%		19.6
OIL %		4.90
STARCH %		34.7
PROTEIN SOLUBLE %		3.9
PHYTATE PHOSPHOROUS mg/100 gm	1020	
CALCIUM (Ca) %		0.32
PHOSPHOROUS (P) %		1.09
POTASIUUM (K) %		1.13
MAGNESIUUM (Mg) %		0.32
IRON (Fe) mg/kg	122	
VITAMIN B. mg/kg (thiamine)		5.0
VITAMIN B ² mg/kg (riboflavin)		2.2
NIACIN mg/kg		192

BREAKAGE & GERM

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AMOUNT RECOVERED: 47kg/hr.

% BREAKAGE: 1.3%

FLOW RATE TO TEMPER BINS: 3410 kg/hr. (F.N. = 310)

FLOUR COLOUR VALUE: 2.4 (improved from 3.6)

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EXAMPLE NO. 4

GRAIN DESCRIPTION: XMR - Hard English Wheat (FN = 200)

FEED RATE: 3500 kg/hr.

MOISTURE ADDED IN DAMPENING MIXER 1.25%

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FIRST FRICTION: 750 RPM

SECOND FRICTION: 750 RPM; MOISTURE ADDED 1/4%

PRODUCT A:

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AMOUNT RECOVERED 84 kg/hr.

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ANAYLSIS		
	Fine	Course
Ash	2.05%	2.55%
Starch	9.9%	11.8%
Dietary Fibre	58.9%	69.2%

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FIRST ABRASION: 840 RPM;

PRODUCT B:

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AMOUNT RECOVERED: 68 Kg/Hr.

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ANALYSIS	
Ash	7.6%
Protein	19.2%
Dietary Fibre	23.9%
Starch	22.4%
Protein (soluble)	8.1%
Phytate Phosphorous	1175 mg/100 gram
Vitamin B ¹	6.0 mg/kg
Vitamin B ²	2.6 mg/kg
Niacin	327 mg/kg

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SECOND ABRASION: 840 RPM;

PRODUCT C:

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AMOUNT RECOVERED: 110 kg/hr.

PRODUCT C:

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ANALYSIS	
Ash	4.6%
Protein	18.15%
Dietary Fibre	11.9%
Starch	40.3%
Protein Soluble	5.3%
Phytate Phosphorous	880 mg/100 gram
Vitamin B ¹	4.6 mg/kg
Vitamin B ²	1.7 mg/kg
Niacin	180 mg/kg

BREAKAGE & GERM

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AMOUNT RECOVERED: 48 kg/hr.

% BREAKAGE: 1.5%

FLOW RATE TO TEMPER BINS: 3220 kg/hr. (FN = 250)

FLOUR COLOUR VALUE: 2.5 (improved from 3.7)

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EXAMPLE NO. 5

GRAIN DESCRIPTION: CWRS (Canadian Western Spring Wheat)

FEED RATE: 3750 Kg/Hr.

MOISTURE ADDED IN DAMPENING MIXER: 2.0

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FIRST FRICTION: 750 RPM

SECOND FRICTION : 750 RPM; MOISTURE ADDED 1/4%

PRODUCT A:

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AMOUNT RECOVERED: 118 kg/hr

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ANALYSIS		
	Fine	Medium
DIETARY FIBRE (dry basis)	69.6%	76.6 %
MOISTURE	13.69	12.59

FIRST ABRASION: 840 RPM:

10 PRODUCT B:

AMOUNT RECOVERED: 97 kg/hr

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ANALYSIS	
MOISTURE%	10.60
ASH%	7.20
PROTEIN %	20.5
DIETARY FIBRE NDF%	39.9
OIL %	6.10
STARCH %	10.8
PROTEIN SOLUBLE %	5.0
PHYTATE PHOSPHOROUS mg/100 gm	1470
CALCIUM (ca) %	0.10
PHOSPHOROUS (P) %	1.68
POTASSIUM (K) %	1.56
MAGNESIUM (Mg) %	0.50
IRON (Fe) mg/kg	171
VITAMIN B ¹ mg/kg (thiamine)	7.1
VITAMIN B ² mg/kg (riboflavin)	2.9
NIACIN mg/kg	304

SECOND ABRASION: 840 RPM

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PRODUCT C:

AMOUNT RECOVERED: 122 kg/hr.

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ANALYSIS	
MOISTURE %	10.35
ASH %	5.00
PROTEIN %	24.8
DIETARY FIBRE NDF%	22.8
OIL %	5.70
STARCH %	24.8
PROTEIN SOLUBLE %	5.3
PHYTATE PHOSPHOROUS mg/100 gm	1100
CALCIUM (Ca) %	0.18
PHOSPHOROUS (P) %	1.28
POTASSIUM (K) %	1.09
MAGNESIUM (Mg) %	0.41
IRON (Fe) mg/kg	122
VITAMIN B, (thiamine) mg/kg	6.6
VITAMIN ² (riboflavin) mg/kg	2.6
NIACIN mg/kg.	285

BREAKAGE & GERM

AMOUNT RECOVERED: 63 kg/hr.

% BREAKAGE: 1.7%

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EXAMPLE No. 6

The following analysis was performed on products A, B, and C obtained by processing Spanish wheat in accordance with the apparatus of Fig. 9. Products A, B and C were divided into coarse and fine particles.

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	A - fine	A-coarse	B-fine	B-coarse	C-fine	C- coarse
Moisture (as red'd	21.40 %	20.80%	10.60 %	10.55 %	10.35 %	10.35 %
ANALYSIS ON D.M. BASIS						
Oil (Procedure A)	1.35 %	1.25 %	8.2 %	7.3 %	6.45 %	6.45 %
Protein	7.9 %	5.6 %	22.75%	19.75%	22.85%	22.1 %
Ash	3.3 %	2.1 %	8.1 %	7.1 %	5.15%	5.3 %
Calcium (Ca)	0.28 %	0.25 %	0.13%	0.22%	0.16%	0.13%
Phosphorus (P)	0.27 %	0.20 %	1.06%	0.98%	1.04%	0.89%
Potassium (K)	0.90 %	0.87 %	2.02%	1.73%	1.41%	1.43%
Magnesium (Mg)	654 mg/kg	649 mg/kg	808 mg/kg	803 mg/kg	772 mg/kg	744 mg/kg
Iron (Fe)	467 mg/kg	307 mg/kg	257 mg/kg	233 mg/kg	184 mg/kg	184 mg/kg
NDF (enzymic)	79.6 %	87.5 %	24.4 %	41.6%	17.5 %	18.4 %
Starch	16.8 %	13.8 %	26.0 %	12.7%	42.4 %	29.3 %
Lignin	2.8 %	0.2 %	1.1 %	1.8%	0.2 %	0.3 %
Cellulose	30.3 %	24.7 %	8.2 %	12.4%	2.8 %	8.1 %
Phytate phosphorus (as P)	100 mg/100 gm	245 mg/100 gm	1580 mg/100 gm	1310 mg/100 gm	980 mg/100 gm	980 mg/100 gm
Protein soluble in 5 % potassium sulphate	1.4 %	1.0 %	10.6 %	10.1%	8.5 %	9.3 %
Copper (Cu)	7.8 mg/kg	6.1 mg/kg	20 mg/kg	19 mg/kg	14.5 mg/kg	14.5 mg/kg
Zinc (Zn)	83 mg/kg	53 mg/kg	139 mg/kg	123 mg/kg	110 mg/kg	117 mg/kg
Selenium (Se)	-	-	-	-	0.1 mg/kg	0.09 mg/kg
Thiamine	2.5 mg/kg	1.9 mg/kg	8.8 mg/kg	7.2 mg/kg	6.8 mg/kg	7.3 mg/kg
Riboflavin	3.1 mg/kg	1.6 mg/kg	2.9 mg/kg	2.7 mg/kg	1.9 mg/kg	2.0 mg/kg
Niacin	Less than 30 mg/kg	Less than 30 mg/kg	351 mg/kg	292 mg/kg	210 mg/kg	201 mg/kg

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The method steps and apparatus therefor, have been described in the preferred embodiment where the bran layers are stripped to expose the endosperm or where the bran layers has been removed with a portion of the aleurone cells remaining to maximize the yield of endosperm.

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Claims

1. A process for treating clean dry wheat kernels (2) having an endosperm (6) and a germ (8) encased in a layered bran coat (4), said process being intended to substantially remove the exposed bran coat (4) and being characterised by comprising, prior to the tempering and conditioning step of a conventional milling process, the following steps, while maintaining the endosperm (6) substantially integral: moistening the clean dry wheat kernels (2) with water to an amount of about 1 to 3% by weight of the

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kernels (2), sufficient to condition the outer layers (14, 16, 18, 20) of the bran coat (4) without fusing the layers (10, 11, 12, 14, 16, 18, 20) together;

feeding said kernels (2), within a period of one to about five minutes after application of the water, in a continuous stream through friction operations to substantially remove and separate the four outer bran layers (14, 16, 18, 20); and

feeding said kernels (2) in a continuous stream through abrasion operations to remove and separate the inner bran layers (10, 11, 12).

2. The process as claimed in claim 1 wherein at least 70% of said bran coat (4) is removed by said process.
3. A process as claimed in claim 1 wherein a first friction operation primarily removes the epidermis and hypodermis layers (18,20) of the bran coat (4) and separates the removed layers from the wheat kernels whereafter the remaining portion of the wheat kernels are subject to further friction and abrasion operations to progressively remove the remaining layers of bran.
4. A process as claimed in claim 3 wherein said remaining layers of bran including cross cells (16), tube cells (14), seed coat (12), nucellar layer (11) and aleurone layer (10) are progressively removed by substantial removal of the cross cells (16) and tube cells (14) in a second friction operation followed by abrasive removal of the said seed coat (12), nucellar layer (11) and at least part of the aleurone layer (10).
5. A process as claimed in claim 4 wherein an additional step of fogging with about 0.25% to 0.50% by weight water is added at the commencement of or during the second friction operation.
6. A process as claimed in claim 4 including separately removing and storing the removed layers after each friction operation.
7. A process as claimed in claim 6 wherein after the abrasive removal of the seed coat (12), nucellar layer (11) and aleurone layer (10), the kernels are fed to a brush apparatus to remove residual bran powder and loosen the germ.
8. A process as claimed in claim 7 including the additional step of feeding the kernels in a continuous stream through a cooling operation if required.
9. A process as claimed in claims 4 or 7 wherein the processed kernels are mixed with atomised water to bring the moisture level of the endosperm (6) to a desired level and fuse the bran coat remaining in the crease of the kernel and then tempering and milling the wheat kernels into flour or semolina.
10. A process as claimed in claim 1 wherein the dampened wheat is held in a holding bin (405) for said period of one to about five minutes such that the outer bran layers are moistened without fusing together, wherein said friction operations comprise feeding the dampened wheat through at least one friction means (406,408) to remove the outer four layers of the bran coat; and wherein said abrasion operations comprise feeding the remaining portion of the wheat kernels through at least one subsequent abrasion means (412,416) to sequentially remove the remaining layers of the bran coat.
11. A process as claimed in claim 10 wherein said friction means includes a first friction operation (406) wherein the outer layers of the bran coat are removed and the removed layers of the bran coat separated from the wheat kernels followed by feeding the wheat kernels to a second friction operation (408) to remove the remaining outer layers of the bran coat and separating the removed bran layers from the wheat kernels.
12. A process as claimed in claim 10 wherein the abrasion means comprises a first abrasion operation (412) for removal of the seed coat, nucellar layers and part of the aleurone layers of the bran coat and a second abrasion operation (416) for removal of the remaining seed coat, nucellar layer and aleurone layer, wherein during the first and second abrasion operation the removed bran layers are separated from the wheat kernels.

13. A process as claimed in claim 12 wherein the bran layers removed during the first abrasion operation (412) are separated from any broken bits or removed germ, collected and stored.
14. A process as claimed in claim 13 wherein the bran layers removed during the second abrasion operation (416) are separated from any broken bits or removed germ, collected and stored.
15. A process as claimed in claim 13 wherein the wheat kernels are subject to the following additional steps:
 - a) feeding the processed wheat kernels to brush means (419) to remove any bran powder from the crease of the wheat kernels or any loosened germ;
 - b) if required, cooling the wheat to a temperature of between 70° to 90° F;
 - c) then adding water to the processed wheat in a dampening mixer (424).
16. A process as claimed in claim 15 where the amount of water added in step (a) is sufficient to fuse any remaining layers of the bran coating and mellow the endosperm to a level suitable for milling.
17. A process as claimed in claim 16 whereby the wheat kernels are then:
 - a) fed to a pre-break means (435) to prebreak the wheat and loosen the germ;
 - b) the broken wheat is then delivered to sifter means (436) to remove the germ and separate the broken wheat into stock sizes for delivery either to the break rolls, a germ sizing system, purifier or a finished product collection system.
18. The process as claimed in claim 10 wherein the wheat kernels exiting the friction operation are held in a holding bin (411) for about 15-30 minutes before being fed to the abrasion means.

Patentansprüche

1. Verfahren zur Behandlung von sauberen trockenen Weizenkörnern (2), die ein Endosperm (6) und einen Keimling (8) haben, der in einer geschichteten Kleiehülle (4) eingeschlossen ist, das Verfahren darauf abgestellt ist, im wesentlichen die freiliegende Kleiehülle (4) zu entfernen, und dadurch **gekennzeichnet** ist, daß es vor dem Anmach(tempering)- und Konditionierungsschritt eines üblichen Mahlverfahrens folgende Schritte umfaßt, während das Endosperm (6) im wesentlichen ganz beibehalten wird:
Befeuchten der sauberen trockenen Weizenkörner mit Wasser bis zu einer Menge von etwa 1 bis 3 Gew.% der Körner (2), ausreichend um die äußereren Schichten (14, 16, 18, 20) der Kleiehülle (4) zu konditionieren, ohne die Schichten (10, 11, 12, 14, 16, 18, 20) miteinander zu verquellen;
Hindurchführen der Körner (2) innerhalb einer Zeitspanne von einer bis etwa fünf Minuten nach Anwendung des Wassers in einem kontinuierlichen Strom durch Reibvorgänge, um im wesentlichen die vier äußeren Kleieschichten (14, 16, 18, 20) zu entfernen und abzutrennen; und
Zuführen der Kerne (2) in einem kontinuierlichen Strom durch Schleifvorgänge, um die inneren drei Schichten (10, 11, 12) zu entfernen und abzutrennen.
2. Verfahren nach Anspruch 1, dadurch **gekennzeichnet**, daß mindestens 70% der Kleiehülle (4) durch das Verfahren entfernt wird.
3. Verfahren nach Anspruch 1, dadurch **gekennzeichnet**, daß ein erster Reibvorgang vorwiegend die Epidermis- und Hypodermissschicht (18, 20) der Kleiehülle (4) entfernt und die entfernten Schichten von den Weizenkörnern trennt, worauf der verbleibende Teil der Weizenkörner einem weiteren Reib- und Schleifvorgang unterworfen wird, um fortschreitend die vorbleibenden Schichten der Kleie zu entfernen.
4. Verfahren nach Anspruch 3, dadurch **gekennzeichnet**, daß die verbleibenden Schichten der Kleie, die Querzellen (16), Schlauchzellen (14), eine Samenschale (12), eine Eikernschicht (11) und eine Aleuronschicht (10) enthalten, fortschreitend durch die im wesentlichen erfolgende Entfernung der Querzellen (16) und der Schlauchzellen (14) in einem zweiten

Reibvorgang entfernt werden, an dem sich eine mittels Schleifen erfolgende Entfernung der Samenschale (12) der Eikernschicht (11) und mindestens eines Teils der Aleuronschicht (10) anschließt.

5. Verfahren nach Anspruch 4,
5 dadurch **gekennzeichnet**, daß
ein zusätzlicher Vernebelungsschritt mit etwa 0,25 Gew.% bis 0,50 Gew.% Wasser zu Beginn oder während des zweiten Reibvorgangs hinzugefügt wird.
6. Verfahren nach Anspruch 4,
10 **gekennzeichnet** durch
getrenntes Entfernen und Speichern der entfernten Schichten nach jedem Reibvorgang.
7. Verfahren nach Anspruch 6,
dadurch **gekennzeichnet**, daß
15 nach der durch Schleifen erfolgten Entfernung der zweiten Samenschalen (12) der Eikernschicht (11) und der Aleuronschicht (10) die Körner einer festen Anordnung zugeführt werden, um zurückgebliebenes Kleiepulver zu entfernen und den Keimling zu lösen.
8. Verfahren nach Anspruch 7,
20 dadurch **gekennzeichnet**, daß
der zusätzliche Schritt der Zufuhr der Kerne in einem kontinuierlichen Strom durch einen Kühlvorgang, falls erforderlich, ausgeführt wird.
9. Verfahren nach Anspruch 4 oder 7,
25 dadurch **gekennzeichnet**, daß
die verarbeiteten Körner mit zerstäubtem Wasser vermischt werden, um den Feuchtigkeitspegel des Endosperms (6) auf einen gewünschten Wert zu bringen und die in der Furche des Korns verbleibende Kleiehülle zu verquellen und anschließend Anmachen und Vermahlen der Weizenkörner zu Mehl oder Grieß erfolgt.
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10. Verfahren nach Anspruch 1,
dadurch **gekennzeichnet**, daß
der befeuchtete Weizen in einem Aufnahmebehälter (405) für die genannte Zeitspanne von einer bis etwa fünf Minuten gehalten wird, so daß die äußeren Kleieschichten befeuchtet werden, ohne miteinander zu verquellen, daß die Reibvorgänge die Zuführung des befeuchteten Weizens durch mindestens eine Reibvorrichtung (406, 408) umfassen, um die äußeren vier Schichten der Kleiehülle zu entfernen; und daß die Schleifvorgänge die Zuführung des verbleibenden Teils der Weizenkörner durch mindestens eine nachfolgende Schleifvorrichtung (412, 416) umfassen, um aufeinanderfolgend die verbleibenden Schichten der Kleiehülle zu entfernen.
40
11. Verfahren nach Anspruch 10,
dadurch **gekennzeichnet**, daß
die Reibvorrichtung einen ersten Reibvorgang (406) umfaßt, bei dem die äußeren Schichten der Kleiehülle entfernt werden und die entfernten Schichten der Kleiehülle von den Weizenkörnern getrennt werden, worauf sich die Zufuhr der Weizenkörner zu einem zweiten Reibvorgang (408) anschließt, um die verbleibenden äußeren Schichten der Kleiehülle zu entfernen und die entfernten Kleieschichten von den Weizenkörnern zu trennen.
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12. Verfahren nach Anspruch 10,
50 dadurch **gekennzeichnet**, daß
die Schleifvorrichtung einen ersten Schleifvorgang (412) umfaßt, um die Samenschale, die Eikernschichten und einen Teil der Aleuronschichten der Kleiehülle zu entfernen und einen zweiten Schleifvorgang (416) zur Entfernung der verbleibenden Samenschale, der Eikernschicht und der Aleuronschicht, und während des ersten und zweiten Schleifvorgangs die entfernten Kleieschichten von den Weizenkörnern getrennt werden.
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13. Verfahren nach Anspruch 12,
dadurch **gekennzeichnet**, daß

die während des ersten Schleifvorgangs (412) entfernten Kleieschichten von jeglichen gebrochenen Stücken oder entfernten Keimling getrennt, gesammelt und gespeichert werden.

14. Verfahren nach Anspruch 13,
5 dadurch **gekennzeichnet**, daß
die während des zweiten Schleifvorgangs (416) entfernten Kleieschichten von jeglichen gebrochenen Stücken oder entfernten Keimling getrennt, gesammelt und gespeichert werden.
15. Verfahren nach Anspruch 13,
10 dadurch **gekennzeichnet**, daß
die Weizenkörner folgenden zusätzlichen Schritten unterworfen werden:
 - a) Zuführung der verarbeiteten Weizenkörner zu einer Bürstenanordnung (419), um jegliches Kleiepulver aus der Furche der Weizenkörner zu entfernen oder jeglichen gelösten Keimling;
 - b) Falls erforderlich, Kühlen des Weizens auf eine Temperatur zwischen 21 und 32 °C (70 ° bis 90 ° F);
 - 15 c) Anschließend Zugabe von Wasser zum verarbeiteten Weizen in einem befeuchtenden Mischer (424).
16. Verfahren nach Anspruch 15,
20 dadurch **gekennzeichnet**, daß
die im Schritt (a) hinzugefügte Wassermenge ausreichend ist, um jegliche verbleibende Schichten der Kleiehülle zu verquellen und das Endosperm auf einen zum Vermahlen geeigneten Pegel mürbe zu machen.
- 25 17. Verfahren nach Anspruch 16,
dadurch **gekennzeichnet**, daß
die Weizenkörner dann
 - a) einer Vorab-Brechvorrichtung (435) zugeführt werden, um den Weizen vorab zu brechen und den Keimling zu lösen;
 - 30 b) der gebrochene Weizen darauf einer Sichtvorrichtung (436) zugeführt wird, um den Keimling zu entfernen und den gebrochenen Weizen in Vorratsgrößen zur Abgabe entweder an Brechwalzen, ein Keimlingklassierungssystem, eine Reinigungsvorrichtung oder ein Sammelsystem für das Endprodukt zu trennen.
- 35 18. Verfahren nach Anspruch 10,
dadurch **gekennzeichnet**, daß
die aus dem Reibvorgang austretenden Weizenkörner in einem Aufnahmebehälter (411) während etwa 15 - 30 Minuten gehalten werden, bevor sie der Schleifvorrichtung zugeführt werden.,

40 Revendications

1. Un procédé de traitement de grains de blé propres et secs (2) ayant un endosperme (6) et un germe (8) recouvert d'une enveloppe stratifiée de son (4), ledit procédé étant destiné à enlever essentiellement l'enveloppe exposée de son (4) et étant caractérisé en ce qu'il comprend, avant l'étape de
45 broyage et de conditionnement d'un traitement classique de meunerie, les étapes suivantes, tout en gardant l'endosperme (6) essentiellement intact :
humectation des grains de blé propres et secs (2) avec de l'eau en une quantité d'environ 1 à 3% en poids des grains (2), suffisante pour conditionner les couches externes (14, 16, 18, 20) de l'enveloppe de son (4) sans que les couches (10, 11, 12, 14, 16, 18, 20) s'amalgament les unes aux autres;
50 alimenter avec lesdits grains (2), dans un temps de une à environ cinq minutes après l'application de l'eau, un flux continu passant à travers des opérations de friction pour enlever et séparer de façon substantielle les quatre couches de son externes (14, 16, 18, 20) ; et
alimenter avec lesdits grains (2) un flux continu passant à travers des opérations d'abrasion pour enlever et séparer les couches internes de son (10, 11, 12).
- 55 2. Le procédé de la revendication 1 dans lequel au moins 70% de ladite enveloppe de son (4) sont enlevés par ledit procédé.

3. Un procédé selon la revendication 1 dans lequel une première opération de friction enlève en premier lieu les couches de l'épiderme et de l'hypoderme (18, 20) de l'enveloppe de son (4) et sépare les couches éliminées des grains de blé, après quoi la partie restante des grains de blé est soumise à des opérations de friction et d'abrasion supplémentaires pour enlever progressivement les couches de son restantes.
5
4. Un procédé selon la revendication 3 dans lequel lesdites couches de son restantes à l'inclusion des cellules transversales (16), des cellules longitudinales (14), de l'enveloppe de la graine (12), de la couche nucellaire (11) et la couche à aleurone (10) sont progressivement éliminées, par une seconde
10 opération de friction, pour une élimination substantielle des cellules transversales (16) et des cellules longitudinales (14), suivie d'une élimination par abrasion desdites enveloppe de la graine (12), couche nucellaire (11) et au moins une partie de la couche à aleurone (10).
5. Un procédé selon la revendication 4 dans laquelle on ajoute une étape supplémentaire de brumisation avec environ 0,25% à 0,50% en poids d'eau au commencement ou au cours de la seconde opération
15 de friction.
6. Un procédé selon la revendication 4 incluant d'éliminer séparément et de conserver les couches éliminées après chaque opération de friction.
20
7. Un procédé selon la revendication 6 dans lequel après l'élimination par abrasion de l'enveloppe de la graine (12), de la couche nucellaire (11) et de la couche à aleurone (10), les grains sont envoyés dans un dispositif de broissage pour enlever la poudre de son résiduelle et pour désolidariser le germe.
- 25 8. Un procédé selon la revendication 7 incluant comme étape supplémentaire d'alimenter avec les grains un flux continu subissant une opération de refroidissement si cela est nécessaire.
9. Un procédé selon les revendications 4 ou 7 dans lequel les grains traités sont mélangés avec de l'eau atomisée pour porter le niveau d'humidité de l'endosperme (6) à un niveau désiré et pour agglomérer
30 l'enveloppe de son restant dans les plis du grain, et ensuite on effectue un broyage et une mouture des grains de blé en farine ou en semoule.
10. Un procédé selon la revendication 1 dans lequel le blé humecté est maintenu dans un silo de contention (405) pendant ladite période de une à environ cinq minutes de façon à ce que les couches
35 externes de son soient humidifiées sans se coller les unes aux autres, dans lequel lesdites opérations de friction comprennent d'introduire le blé humecté dans au moins un dispositif de friction (406, 408) pour enlever les quatre couches externes de l'enveloppe de son ; et dans lequel lesdites opérations d'abrasion comprennent d'introduire ensuite la partie restante des grains de blé dans au moins un dispositif d'abrasion (412, 416) pour enlever séquentiellement les couches restantes de l'enveloppe de son.
40
11. Un procédé selon la revendication 10 dans lequel ledit dispositif de friction inclut une première opération de friction (406) dans lequel les couches externes de l'enveloppe de son sont éliminées et les couches de l'enveloppe de son éliminées sont séparées des grains de blé, suivie d'une introduction
45 des grains de blé dans une seconde opération de friction (408) pour enlever les couches externes restantes de l'enveloppe de son, et d'une séparation des couches de son éliminées et des grains de blé.
12. Un procédé selon la revendication 10 dans lequel le dispositif d'abrasion comprend une première
50 opération d'abrasion (412) pour l'élimination de l'enveloppe de la graine, des couches nucellaires et d'une partie des couches à aleurone de l'enveloppe de son et une seconde opération d'abrasion (416) pour l'élimination de l'enveloppe de la graine, de la couche nucellaire et de la couche à aleurone restantes, dans lequel au cours de la première et de la seconde opération d'abrasion les couches de son éliminées sont séparées des grains de blé.
55
13. Un procédé selon la revendication 12 dans lequel les couches de son éliminées durant la première opération d'abrasion (412) sont séparées de tous morceaux de germe cassés ou germes éliminés, récupérés et conservés.

14. Un procédé selon la revendication 13 dans lequel les couches de son éliminées durant la seconde opération d'abrasion (416) sont séparées de tous morceaux de germe cassés ou germes éliminés, récupérés et conservées.
- 5 15. Un procédé selon la revendication 13 dans lequel les grains de blé sont soumis aux étapes supplémentaires suivantes :
- 10 a) introduction des grains de blé traités dans un dispositif de brossage (419) pour éliminer toute poudre de son restant dans les plis des grains de blé ou tout germe désolidarisé;
b) si cela est nécessaire, refroidissement du blé à une température entre 70° et 90° F;
c) puis ajout d'eau au blé traité dans un mélangeur humidifiant (424).
16. Un procédé selon la revendication 15 où la quantité d'eau ajoutée à l'étape a) est suffisante pour agglomérer toute couche restante de l'enveloppe de son et pour ramollir l'endosperme à un niveau suffisant pour la mouture.
- 15 17. Un procédé selon la revendication 16 par lequel les grains de blé sont ensuite :
- 20 a) introduit dans un dispositif dans un dispositif de prébroyage (435) pour pré-broyer le blé et désolidariser le germe ;
b) le blé concassé est ensuite amené dans unasseur (436) pour éliminer le germe et séparer le blé concassé en des lots de taille pour les envoyer ensuite soit vers des broyeurs à rouleaux, soit vers un système de calibrage du germe, soit un purificateur ou encore un système de récupération du produit fini.
- 25 18. Le procédé selon la revendication 10 dans lequel les grains de blé venant de subir l'opération de friction sont maintenus dans un silo de contention (411) pendant environ 15-30 minutes avant d'être envoyés dans le dispositif d'abrasion.

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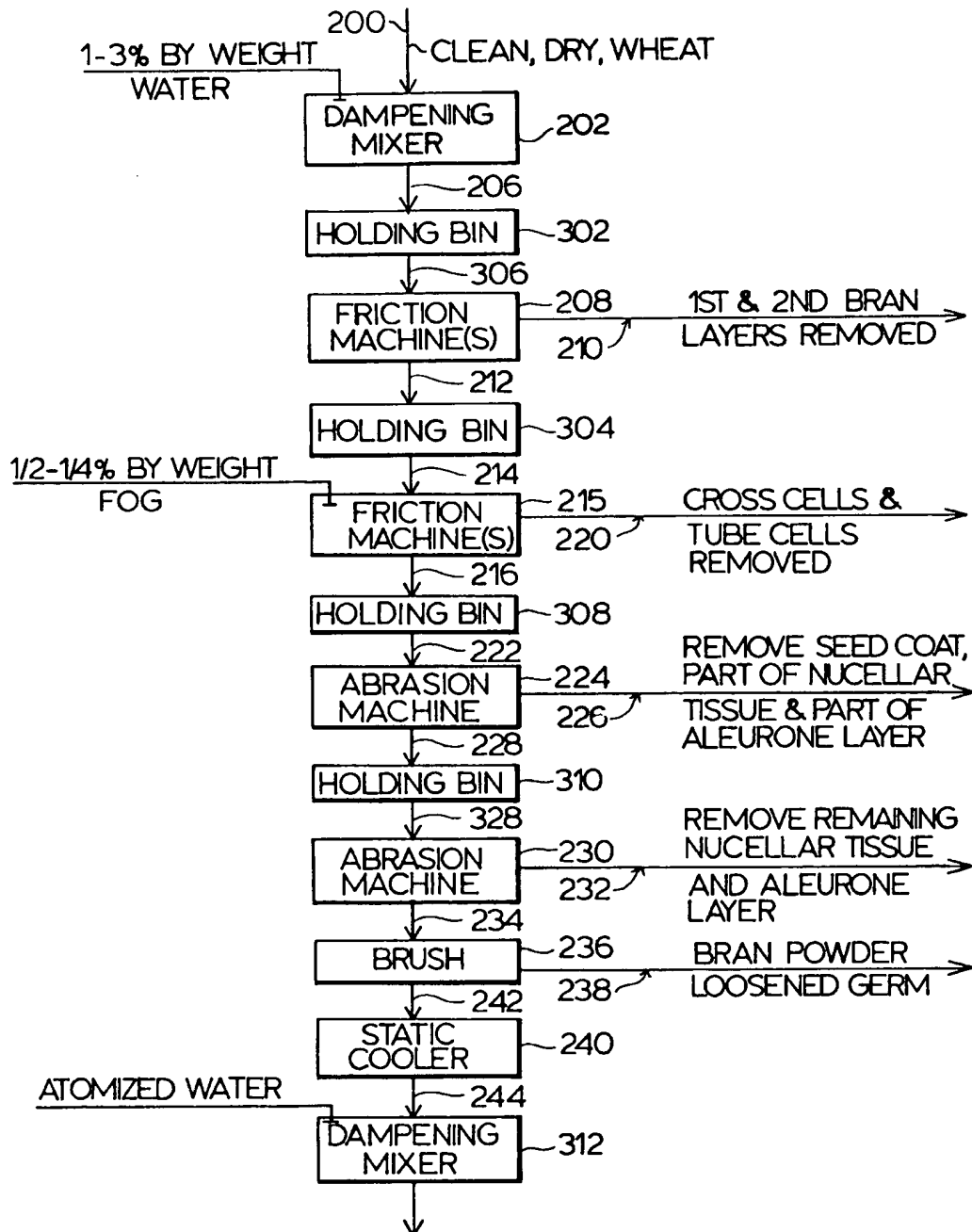
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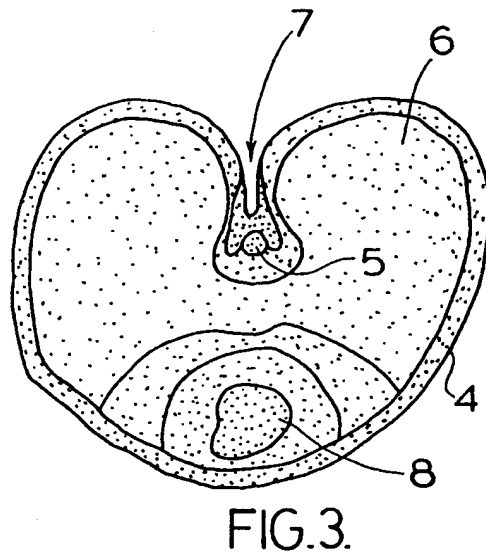
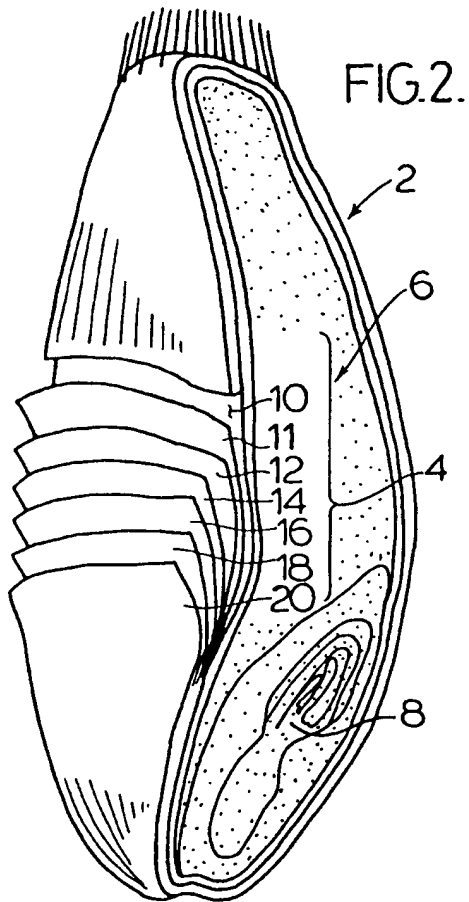
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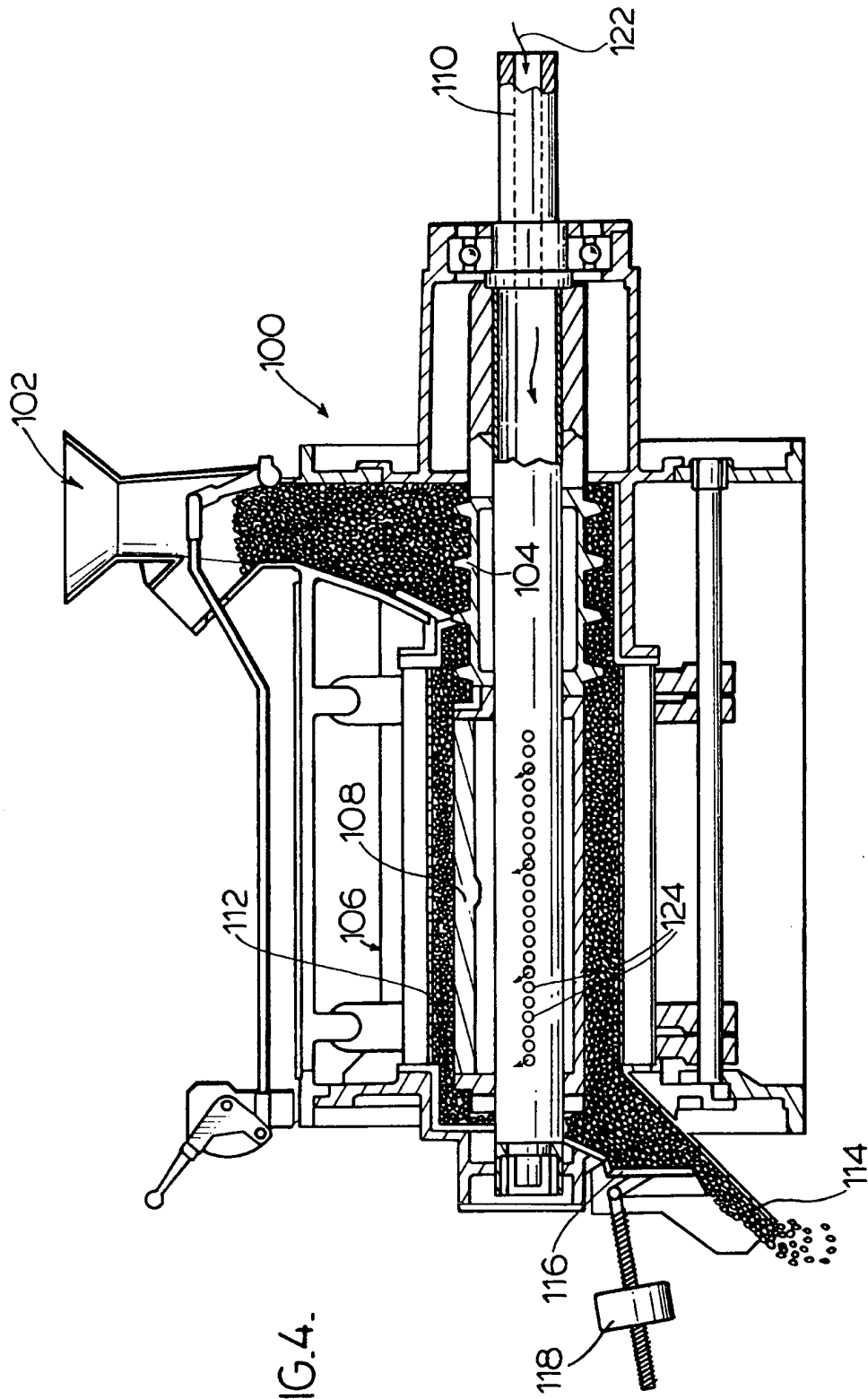
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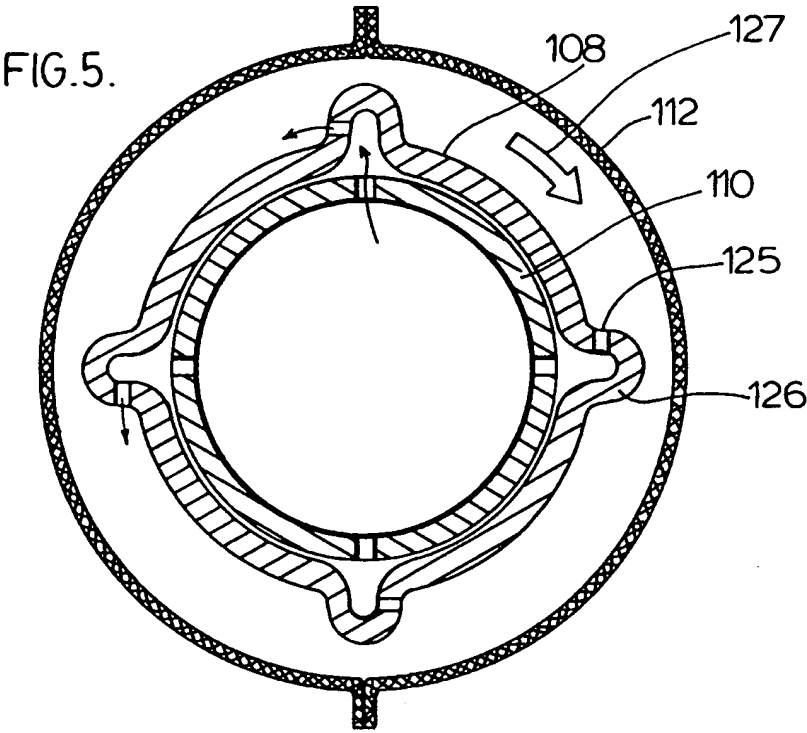
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FIG. 1









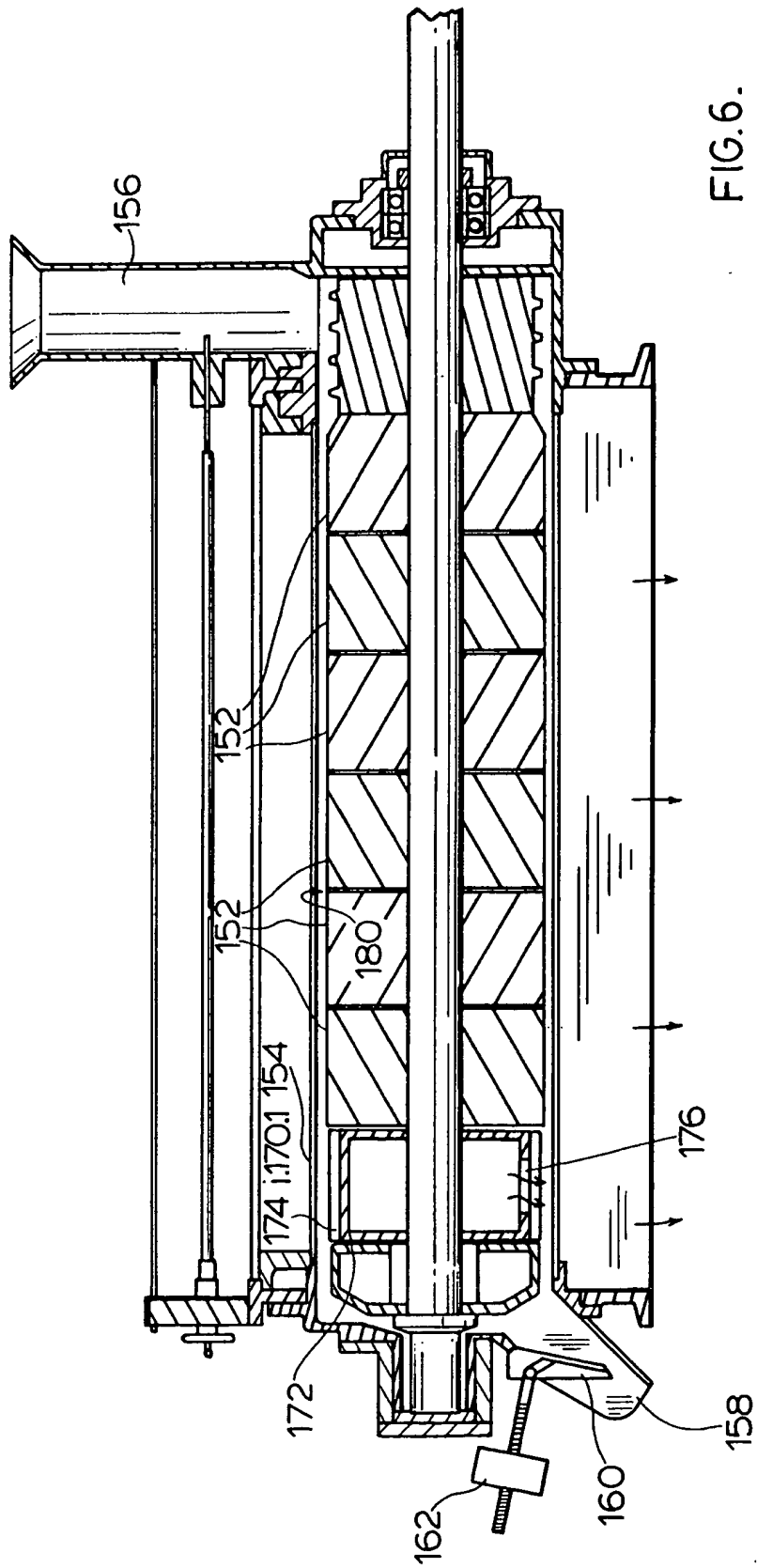


FIG.6.

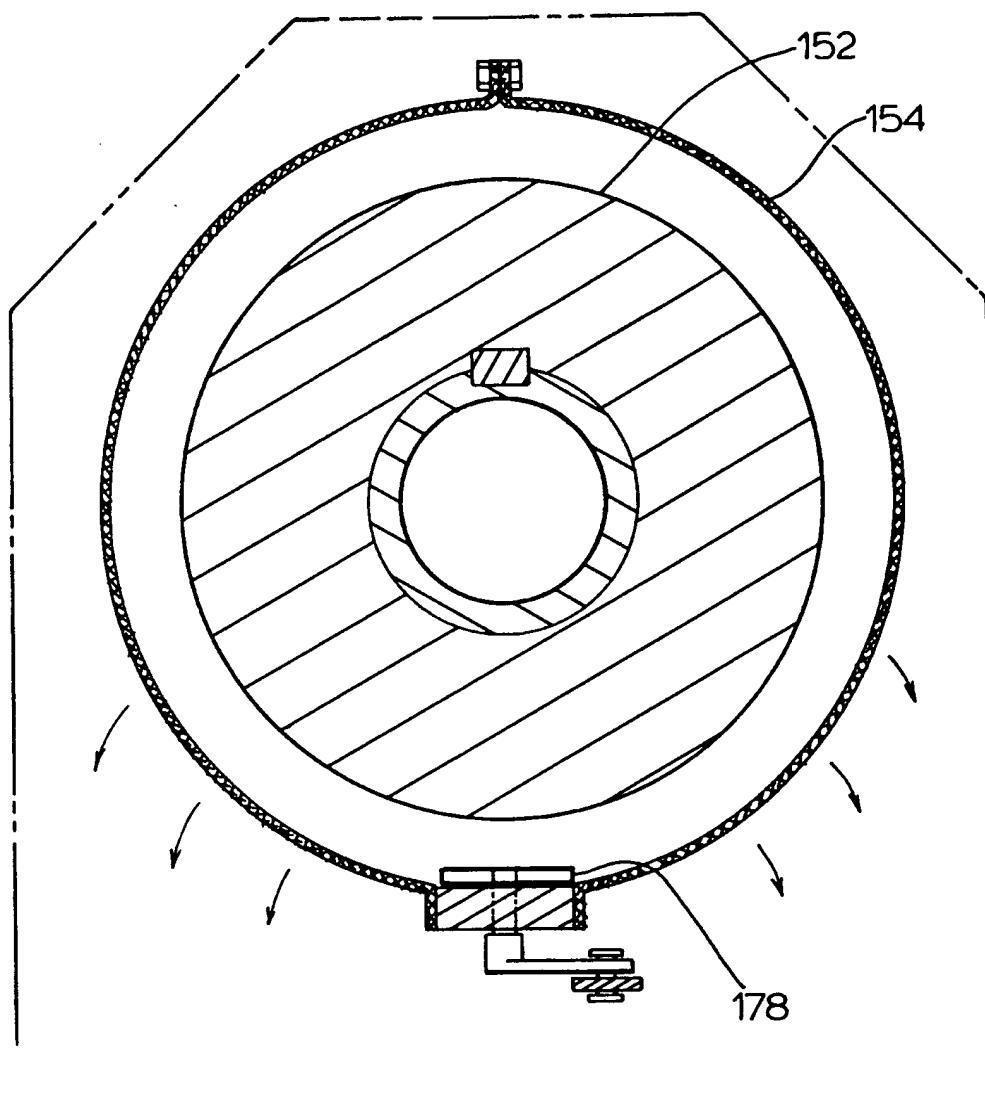
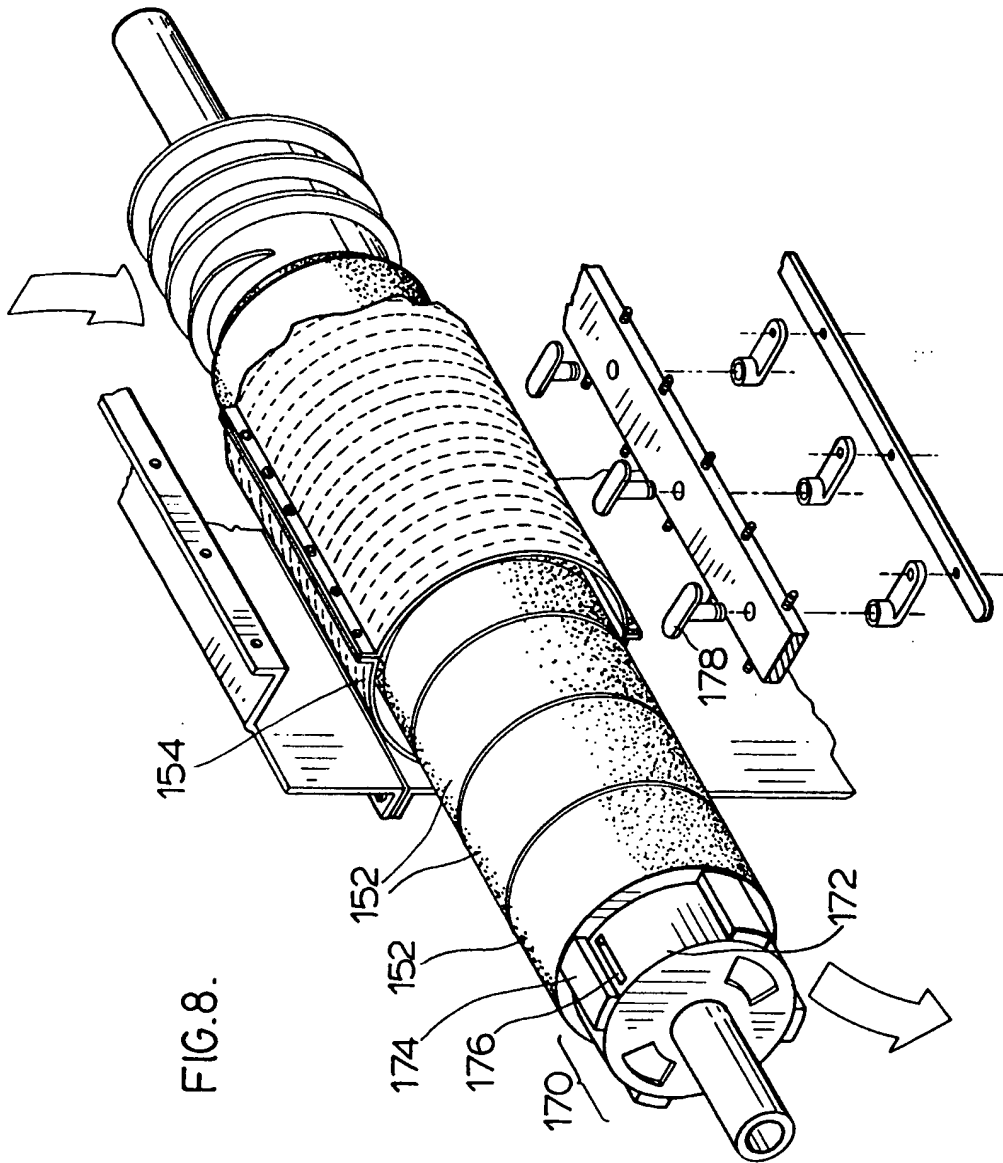


FIG. 7.



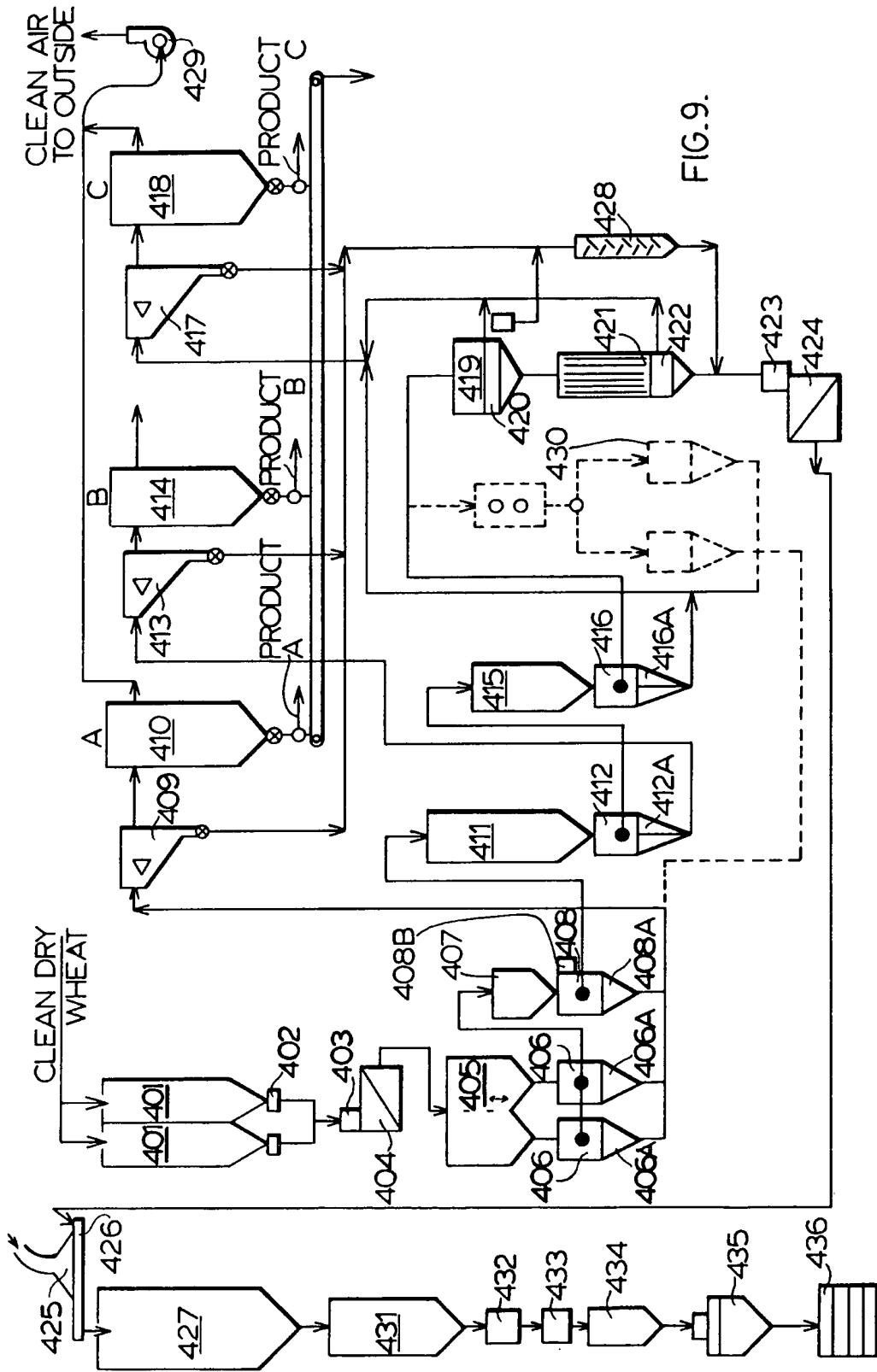


FIG. 9.

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